GSFC 424-28-26-02

UNIQUE INSTRUMENT INTERFACE DOCUMENT (UIID)
FOR THE
TROPOSPHERIC EMISSION SPECTROMETER (TES)

EOS AURA PROJECT

AUGUST 2001

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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EOS AURA PROJECT

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CHANGE RECORD PAGE

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CH-02	04/08/02	Pages iv, v, vi, 5-12, 5-13, 5-14	Approved by the following CCRs: 424-12-26-028, 424-12-26-030, 424-12-26-031, and 424-12-26-033
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CH-04	1/03	Pages iv, v, 4-2	Approved by CCR 424-12-26-034
CH-05	2/03	Pages iv, v, 3-2, 3-3, 3-4, 3-5, 3-6	Approved by CCR424-12-26-027
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SECTION PAGE

ILLUSTRATIONS

TABLES

1.0 SCOPE

The purpose of the Unique Instrument Interface Document (UIID) is to define the special interface requirements that are unique to the instrument. Interface elements not addressed in this UIID are assumed to be compatible with the interface requirements of the EOS General Interface Requirements Document (GIRD).

The information contained herein establishes the constraints that must be adhered to by both the instrument developer and spacecraft developer. The UIID data aids the proper planning and smooth flow of project development.

The interface documentation, referenced in Section 2 of this document, establishes the electrical, mechanical, thermal, and ground support equipment interfaces between the Tropospheric Emission Spectrometer (TES) and the EOS Aura Spacecraft. Section 3 of this document allocates resources for critical elements, such as weight, power, fields of view, pointing, thermal dissipation, and command and data handling. Constraints on the handling and operation of the instrument in shipment and integration and test are described in Section 4. Approved deviations/waivers to applicable documents are listed in Section 5.

The UIID for the EOS TES, in conjunction with the EOS GIRD, establishes the Instrument/EOS Spacecraft interface. The reference document, Interface Control Document (ICD) establishes details of the mechanical, thermal, electrical, and command and data handling interfaces between the TES Instrument and the EOS Aura spacecraft. The IDD will be used for the Phase C/D spacecraft procurement and will be superseded by the Interface Control Document (ICD) negotiated between the spacecraft contractor and the TES instrument developer after Phase C/D contract award. The order of precedence for these documents are UIID, GIRD, IDD/ICD.

Any changes to the UIID, GIRD or IDD must be approved by the EOS Aura Project Configuration Control Board.

2.0 APPLICABLE DOCUMENTS

The requirements stated in the most current released version of the documents listed in this section of the UIID apply to the TES instrument. Section 5.0 of this UIID contains deviations and waivers to the applicable documents that have been approved for the TES instrument.

DOCUMENT NO.	TITLE
422-11-12-01	General Interface Requirements Document (GIRD) for EOS Cdmmon Spacecraft/Instruments
424-11-13-02	Mission Assurance Requirements for the Tropospheric Emission Spectrometer (TES) and the Microwave Limb Sounder (MLS) for the EOS Chemistry Mission

2.1 REFERENCE DOCUMENTS

REFERENCE NO.	TITLE
D26476	Interface Control Document for the Tropospheric Emission Spectrometer, EOS Common Spacecraft Project

3.0 ALLOCATIONS

This section defines the EOS Aura Project resources that are specifically allocated to the EOS TES.

3.1 MECHANICAL ALLOCATIONS

3.1.1 Instrument Mechanical Envelope Allocation

Figure 3-l illustrates the TES instrument overall mechanical envelope allocation for launch conditions. Figure 3-2 illustrates the TES instrument mechanical envelope allocation for on-orbit conditions.

Dimensions, which include external instrument MLI and instrument provided connectors, shall not exceed the mechanical envelope allocation.

3.1.2 Field of View Allocation

Figure 3-3 illustrates the TES instrument Nadir Science Field-of-View allocation, inclusive of all calibration and stay-out-zones. Figure 3-4 illustrates the TES instrument Limb Science Field-of-View allocation, inclusive of all calibration and stay-out zones.

3.1.3 Mass Allocation

Total Instrument	385 kg

Note: Total instrument allocation includes contingency.

3.1.4 Pointing Allocation

Unless otherwise specified, accuracy and knowledge pointing allocation values represent the summation of individually root-sum-squared bias, drift, and jitter terms and are expressed in arcsec measured zero to peak (30). Additionally, unless otherwise specified, stability pointing allocations are expressed in arcsec measured peak to peak (3σ) over defined time intervals.

3.1.4.1 Mission Requirements

Mission pointing requirements are based on instrument science requirements and represent total mission pointing requirements from the instrument line of sight to the Earth Centered Inertial (ECI) reference frame. The ECI reference frame is a right-handed orthogonal Cartesian frame with its origin at the center of the Earth. The X axis is parallel to the line of vernal equinox, with +X pointing toward the sun on the first day of spring. The Z axis is through the Earth's poles, oriented in the South to North direction. The Y axis completes the right-handed orthogonal Cartesian frame. CH-05

Mission Requirements	Roll (X)	Pitch (Y)	Yaw (Z)	Note
Pointing Accuracy (arcsec 3σ)	1560	156	1560	1
Pointing Knowledge (arcsec 3σ)	124	124	124	2
Pointing Stability (arcsec 3σ) (Time Interval)				
50 sec	156	156	156	3
16 sec	N/A	15	N/A	3

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Note 1 – The TES Pointing Control System compensates for the majority of the spacecraft contribution to Mission Pointing Accuracy. The remaining uncompensated portion of the spacecraft contribution, i.e. spacecraft pointing knowledge, when root-sum-squared with the instrument contribution results in unallocated margin at the mission level. The unallocated Mission Pointing Accuracy margin is $(1560^2 - 128^2 - 80^2)^{1/2} = 39$ arcsec in pitch and $(1560^2 - 1037^2 - 80^{1/2} = 1163$ arcsec in roll/yaw.

Note 2 - Pointing knowledge allocations represent the worst case requirement (during limb pointing). Pointing knowledge during nadir pointing shall be 390 arcsec (all axes).

Note 3 - The TES Pointing Control System compensates for the spacecraft contribution to Mission Pointing Stability resulting in unallocated margin at the mission level. The unallocated Mission Pointing Stability margin in the 50 second time domain is $(156^2 - 119^2)^{1/2}$ = 101 arcsec for all axis. The unallocated Mission Pointing Stability margin in the 16 second time domain is $(15^2 - 14^2)^{1/2}$ = 5 arcsec in pitch. CH-05

The following sections allocate portions of the mission requirements to the spacecraft and the instrument. These allocations represent the maximum allowable instrument and spacecraft contributions to mission pointing accuracy, knowledge, and stability error. Unless otherwise specified, spacecraft and instrument allocations when root-sum-squared equal the mission requirement.

3.1.4.2 Spacecraft Allocation

Spacecraft pointing allocations are the spacecraft portion of the mission pointing requirements and represent pointing requirements placed on the spacecraft. Spacecraft pointing knowledge shall be measured from the Instrument Alignment Cube (IAC) to the ECI reference frame. Spacecraft pointing accuracy and stability shall be measured from the Spacecraft/Instrument Mounting Interface (TES Mechanical Datum) to the ECI reference frame. CH-05

For the purpose of enhancing accountability and verification of compliance with individual requirements, in the category of pointing stability, the pointing stability allocations are separately specified as Observatory Level allocations and Spacecraft Bus Level allocations.

The Observatory Level pointing stability allocations (see next page) represent the maximum errors that can be tolerated by the TES instrument at the spacecraft/instrument interface in order to prevent unacceptable deterioration of gathered science data. Such errors depend on the combination of all environmental disturbances, including those produced by TES, the other payload instruments, and the spacecraft. CH-05

The Spacecraft Bus Level pointing stability allocations represent the maximum contribution by the spacecraft bus to the pointing stability errors at the same interface, in the absence of disturbances generated by all of the instruments. Thus the Spacecraft Bus Level allocations represent performance requirement limits placed on the spacecraft bus,

Spacecraft Allocation	Roll (X)	Pitch (Y)	Yaw (Z)	Note
Pointing Accuracy (arcsec 3σ)	500	500	500	4
Pointing Knowledge (arcsec 3σ)	80	80	80	-
Observatory Level Pointing Stability (arcsec 3σ) (Time Interval)				
50 sec	100	100	100	4,5
16 sec	N/A	20	N/A	4,5
Spacecraft Bus Level Pointing Stability (arcsec 3σ) (Time Interval)				
50 sec	N/A	N/A	N/A	6
16 sec	N/A	(TBR)	N/A	6

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Note 4 – Pointing accuracy and Observatory Level pointing stability are uncompensated Observatory Level values. They represent the maximum errors, at the spacecraft/instrument interface, for which the instrument is able to compensate by its own pointing control subsystem and still meet the mission requirements in the presence of the corresponding Instrument Allocation errors.

Note 5 – The ability of the spacecraft to meet Observatory Level pointing stability requirements is dependent upon specific torque/time history data related to disturbances generated by all instruments and the spacecraft bus. Therefore, the spacecraft provider, through jitter and pointing stability capability analysis, shall be responsible for determining the ability of the observatory to meet Observatory Level pointing stability allocations and/or the identification of disturbance sources which preclude meeting those allocations. Conflicts that arise between stated requirements and calculated responses will be addressed on a case by case basis. Instrument disturbances which exceed GIRD torque disturbance limits may be allowed (see section 5.1.7) provided that all instrument pointing stability requirements are met. Approved instrument disturbances which exceed GIRD torque disturbance limits and/or conflict resolutions will be documented in the TES to spacecraft ICD.

Note 6 – Spacecraft and environmental disturbances which result in non-compliance with Spacecraft Bus Level pointing stability allocations may be allowed (see section 5.1.7). These disturbances will be evaluated on a case by case basis through jitter and pointing stability capability analysis to determine whether they result in non-compliance with Observatory Level pointing stability requirements. Approved spacecraft disturbances which are acceptable, even though they result in non-compliance with Spacecraft Bus Level pointing stability allocations, will be documented in the TES to spacecraft ICD.

3.1.4.3 Instrument Allocation

Instrument pointing allocations are the instrument portion of the mission pointing requirements and represent pointing requirements placed on the instrument. Instrument pointing knowledge shall be measured from the instrument line of sight to the IAC. Instrument pointing accuracy and stability shall be measured from the instrument line of sight to the Spacecraft/Instrument Mounting Interface (TES Mechanical Datum). CH-05

Instrument Allocation	Roll (X)	Pitch (Y)	Yaw (Z)	Note
Pointing Accuracy (arcsec 3σ)	1037	128	1037	-
Pointing Knowledge (arcsec 3σ)	95	95	95	-
Pointing Stability (arcsec 30) (Time Interval)				
50 sec	119	119	119	-
16 sec	N/A	14	N/A	-

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3.1.4.4 Co-Alignment Allocation

The TES instrument imposes no instrument co-alignment requirements on the spacecraft.

3.1.4.5 Calibration Maneuvers

The TES instrument imposes no calibration maneuver requirements on the spacecraft.

3.1.5 Instrument Mounting

The mounting plane (mounting points) of the TES instrument shall be parallel to the XY plane relative to the spacecraft body frame. The spacecraft body frame is centered at the center of mass of the observatory with the +Z axis nominally normal to the nadir-facing instrument mounting surface, +X forward in the general direction of flight in normal operation, and Y normal to X and Z. Through the definition of a Master Reference Cube, this is the frame to which instrument bases are mechanically aligned.

The spacecraft mounting configuration shall accommodate four kinematic mounts and orient the TES instrument aperture view in the +Z direction (nadir).

3.2 THERMAL CONTROL ALLOCATION

3.2.1 Thermal Control Methods/Dissipations

The thermal control methods/dissipations allocations are given below.

	LOCAL RADIATOR (WATTS)	COLD PLATE (WATTS)
Nadir Radiators	284	N/A
180K and 230K Radiators	50	N/A
TES Total	334	N/A

Note: The dissipation data given represents only heat generated by the instrument when it is drawing its full power allocation; it does not include absorbed spacecraft and environmental radiation.

3.2.2 Thermal Field of View Allocation

The TES instrument thermal Field-of-View allocation is illustrated in Figure 3-5.

The spacecraft shall accommodate TES such that heat transfer to the TES passive cooler radiator does not exceed 3.0 W/m^2 during normal instrument operation. This additional heat is composed of infrared back loads from all surfaces external to the passive cooler radiator, and all environmental loads arriving at the radiator through all paths, other than directly from the TES instrument, itself.

Thermal field-of-view allocations and heat transfer restrictions are to be considered as an instrument accommodation goal for the spacecraft. Intrusions into thermal field-of-view or higher heat transfer limits may be allowed to properly integrate the entire instrument complement on the spacecraft and will be evaluated on a case by case basis through thermal analyses. Approved excursions will be documented in the TES to spacecraft ICD.

3.3 ELECTRICAL ALLOCATIONS

3.3.1 Power Allocations

Launch Mode	0 Watts
Survival Mode	100 Watts
Operational Mode (2 Orbit Average)	334 Watts
Operational Mode (Peak)	390 Watts

Note: Peak power is the maximum power averaged over any 10 msec period.

3.4 COMMAND AND DATA HANDLING ALLOCATION

3.4.1 Science Data Rate Allocation

	Average Data Rate	Peak Data Rate
Total	4.9 Mbps	6.2 Mbps

3.4.2 Remote Terminal Allocations

The number of functionally distinct MIL-STD-1553 Remote Terminals (addresses) allocated shall be limited to one (1) for the EOS TES Instrument.

3.4.3 Spacecraft Ancillary Data Allocation

3.4.3.1 Spacecraft Data to Instrument (on-orbit)

On-orbit spacecraft ancillary data will be provided to the TES instrument on the spacecraft MIL-STD-1553 data bus. The TES on-orbit spacecraft ancillary data requirements for this interface are listed in Table 3-1. Additionally, the spacecraft shall provide an electrical interface with the instrument for the transfer of high rate gyro data. The requirements for the spacecraft to instrument high rate gyro interface are listed in Table 3-2.

3.4.3.2 Spacecraft Data to Ground (post-processed)

The TES instrument imposes no unique requirements on the spacecraft for telemetered spacecraft ancillary data. However, the spacecraft shall provide, before flight, a gyro to spacecraft body axis coordinate transformation matrix (which transforms gyro outputs to spacecraft body frame coordinates).

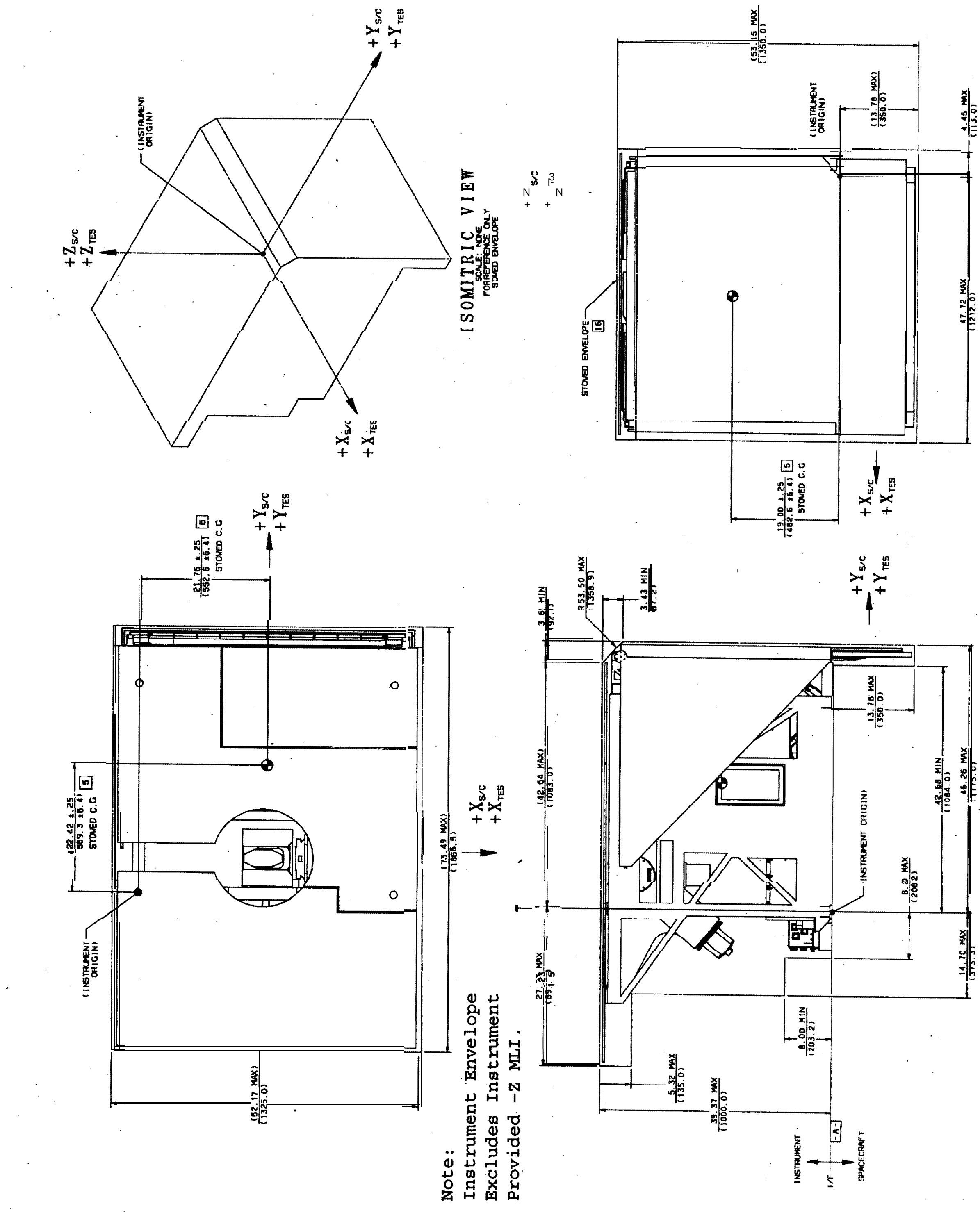


Figure 3-1 TES Launch Mechanical Envelope Allocation

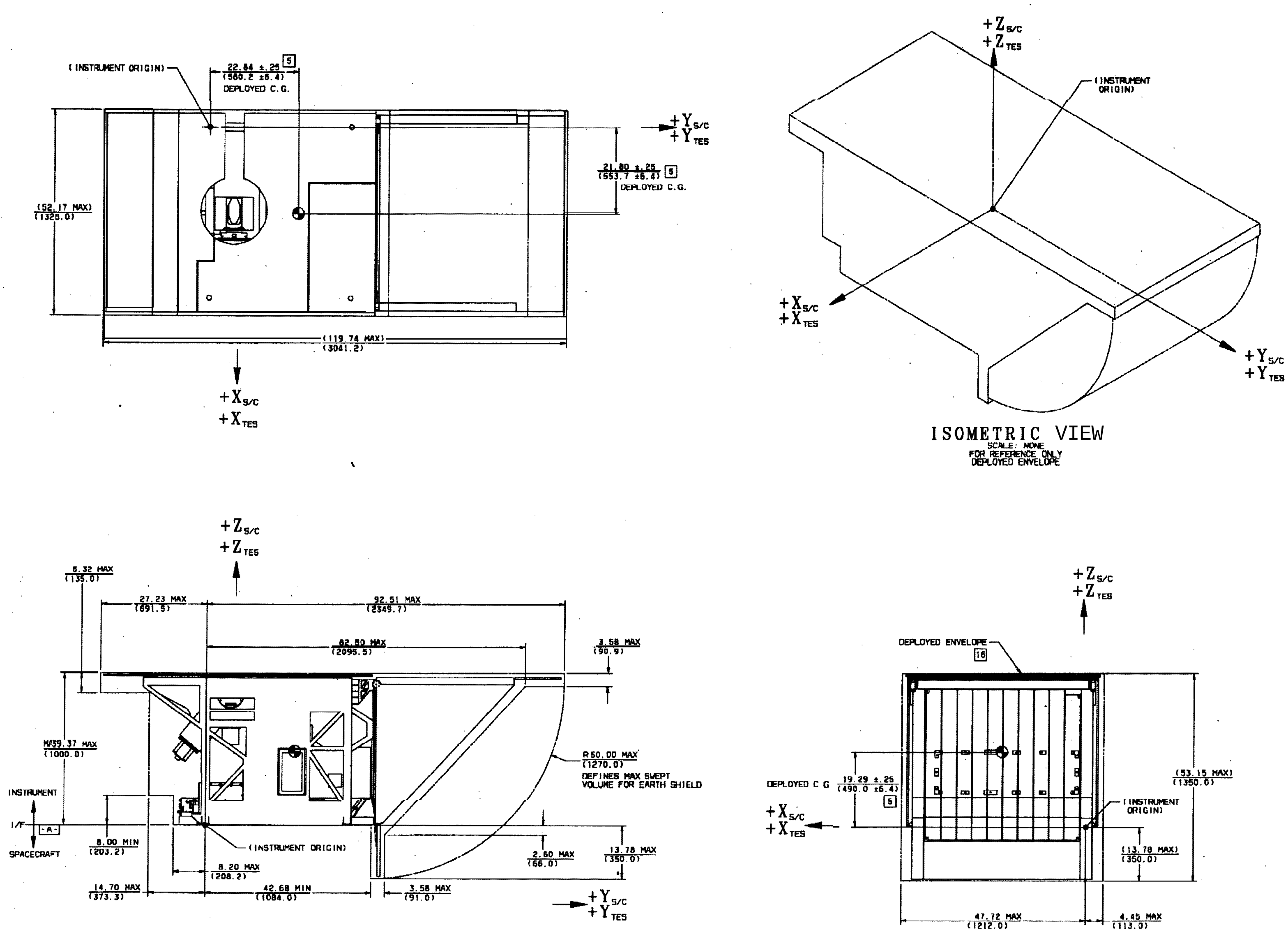


Figure 3-2. TES On-Orbit Mechanical Envelope Allocation

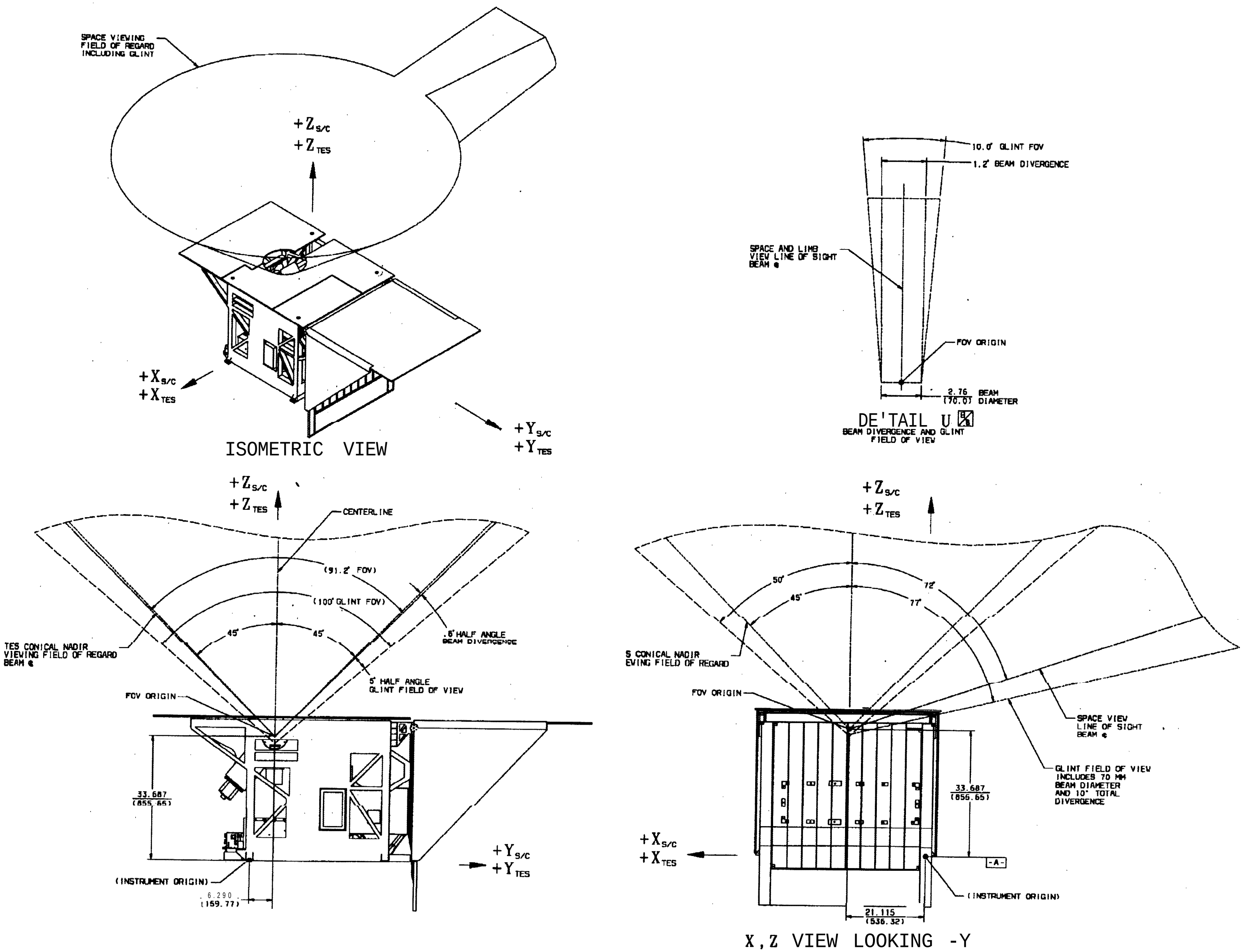


Figure 3-3. TES Nadir Science Field-of-View Allocation

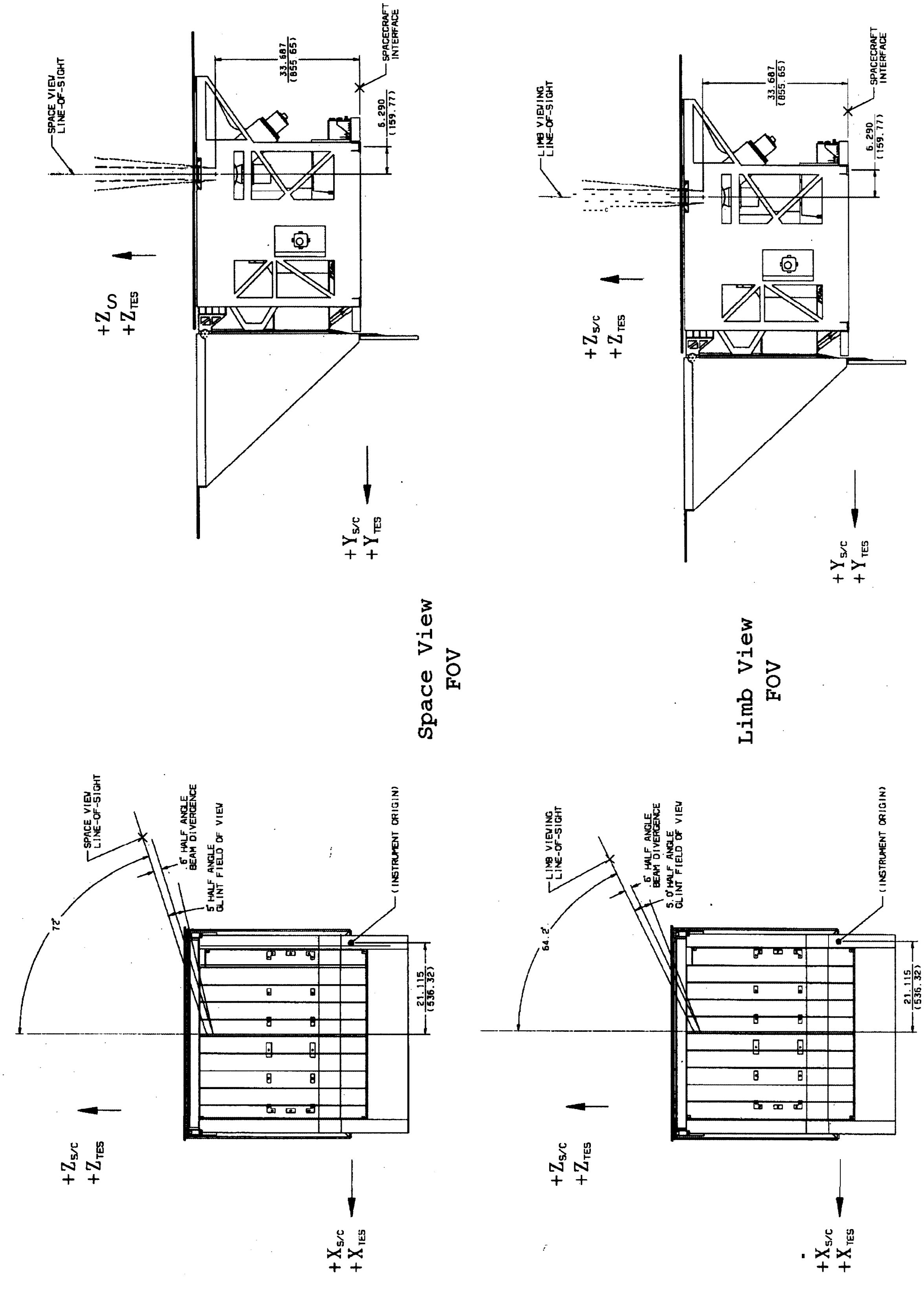


Figure 3-4. TES Limb Science Field-of-view Allocation

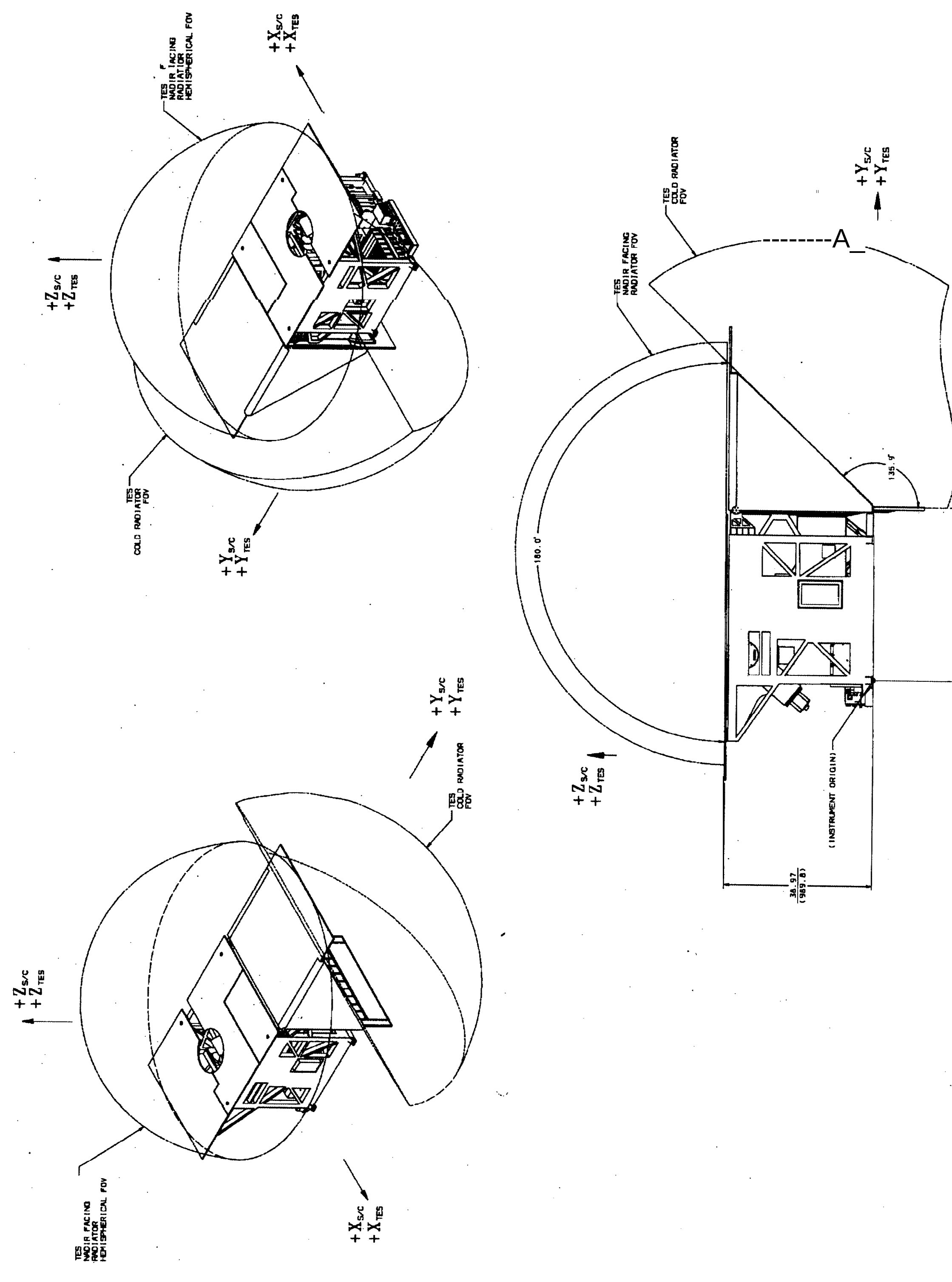


Figure 3-5. TES Thermal Field-of-View Allocation

Table 3-1
Spacecraft Ancillary Data (on-orbit)

Spacecraft Parameter	Description	Knowledge; Resolution	Time Tag Accuracy; Latency	Frequency
Position	ECI XYZ	500 meters; 1 meter	50 msec; <0.5 sec	1 Hz
Velocity	ECI XYZ rates	0.1 meter/sec; 1mm/sec	50 msec; <0.5 sec	1 Hz
Attitude (Note 1)	ECI to spacecraft body frame quaternion	25 arcsec; <0.2 arcsec	50 msec; <0.5 sec	1 Hz
Attitude Rate (roll/pitch/yaw)	Euler angle rates	0.1 arcsec/sec; 0.01 arcsec/sec	50 msec; <0.5 sec	1 Hz
Time	Time signal for onboard data	10 msec; <15.2 microsecond	1 msec; 4.5 sec	1 Hz
Node Crossing	Time of next descending node crossing	4.1 sec; <0.01 sec (or approximately 550 meters knowledge)	50 msec; <0.5 sec	Once per orbit
IRU Status and Gyro Status	IRU configuration bits, gyro status bits	N/A	50 msec; <0.5 sec	1 Hz

Note 1 - Spacecraft attitude shall be the output of the attitude estimator with respect to the ECI reference frame. (Ephemeris errors are not included)

Table 3-2

Spacecraft to Instrument High Rate Gyro Interface

Spacecraft Parameter	Description	Knowledge; Resolution	Latency	Frequency
High Rate Gyro Data (Note 2)	Uncompensated, non-time-tagged high-rate gyro data in gyro coordinates (provided via non-GIRD RS422 interface with spacecraft gyro)	(Per gyro capability)	(Per gyro capability)	100 Hz

Note 2 - Pre-Butterworth filter output (after the sync filter)

4.0 CONSTRAINTS

The information contained in this section defines any constraints in the operation or handling of the instrument that must be observed in order to prevent possible damage or degradation.

4.1 INSTRUMENT OPERATION

The TES instrument shall only be operated by the spacecraft . contractor with the approval and presence of the TES Integration and Test Manager, or a designated representative.

4.2 TEMPERATURE AND HUMIDITY

TES shall not be exposed to a temperature range beyond +5 to +40 degrees C during transportation. During ambient operations the instrument shall not be exposed to a temperature range beyond +10 to +30 degrees C.

TES will not be exposed to humidity greater than 60% for a total time longer than 30 minutes.

4.3 PURGE

A protective purge shall be provided during ambient operation, storage and transportation of the instrument as defined in the ICD.

4.4 TRANSPORTATION

Latchable mechanisms shall be latched for all transportation activities. Standard grounding techniques to ensure ESD protection during transportation shall be employed.

4.5 CRYOCOOLER OPERATIONS

It is highly desirable that the cryocoolers not be operated outside of a hard vacuum. The cryocoolers may, however, be operated for limited times in a carefully controlled purged environment, The duration of these purged-operations periods shall be specified in the ICD. Sufficient time must be allowed for the evaporation of any condensates in between cryocooler operations. (TBR)

4.6 MECHANISMS

The earth shade mechanism will operate at 1g in any orientation, but may require counterbalancing when the instrument +Z axis is parallel to the local gravity vector,

The translator mechanism has operational constraints which shall be documented in the ICD (TBR).

4.7 ORIENTATION

Radiator heat pipes have operational constraints subject to orientation which shall be documented in the ICD.

4.8 LASER OPERATIONS

To conserve laser lifetime, laser operation shall be limited to plannedtesting or the validation of laser health.

4.9 Telemetry Monitoring (TMON) Requirements

In addition to TMONs required for on-orbit operations, TES requires TMONs to be used on orbit and during observatory integration and test (I&T) to provide protection in the event that the cryocoolers are powered without control from the TES command and data handling (C&DH) system. The TMON shall activate and shut down the cryocooler after four 4-second cycles have passed without 1553 TES telemetry (4*4). CH-04

(Ref. CCR 424-12-26-034)

5.0 DEVIATIONS/WAIVERS

The information contained in this section identifies all the deviations/waivers agreed upon by the EOS TES Project Manager and the GSFC EOS Aura Project Manager.

5.1 GIRD DEVIATIONS/WAIVERS

5.1.1 Revised Instrument Input Voltage Requirements

For TES, a deviation to the GIRD (Revision A, Change 3) has been approved which modifies instrument input voltage requirements.

In lieu of the Primary Instrument Voltage requirement for spacecraft provided switched instrument power at +28 +7/-4 Vdc (GIRD paragraph 5.2.5.1.1), the spacecraft shall supply switched instrument power at the instrument's external electrical interface connector(s) at +29 +2 Vdc. Additionally, during instrument power transient conditions, as specified in GIRD paragraph 5.2.5.2.3, the spacecraft supply voltage shall not deviate by more than ±2.9 volts about the supplied voltage.

In lieu of the Abnormal Operation Steady-State Voltage Limits requirement for instrument survival following steady-state voltages in the range of O-50 Vdc (GIRD paragraph 5.2.5.1.4), under failure mode conditions the instrument shall survive, without permanent degradation, spacecraft steady state supply voltages in the range of 0 to 36 Vdc. In addition the instrument shall survive, without permanent degradation, a maximum spacecraft supply voltage of 42 Vdc for durations less than 10 ms.

(Ref. CCR 424-12-26-005)

5.1.2 Center of Mass Measurement Accuracy

The following deviation to GIRD (Revision A, Change 3) paragraph 3.3.3.2 has been approved on the condition that the integrated TES instrument shall be measured for disturbances using a Kistler table or equivalent method of disturbance measurement.

In lieu of measuring and reporting the launch and on-orbit center of mass of the TES Instrument to ±5mm, the launch center of mass of the TES instrument shall be measured and reported to ±8mm in the X and Y axes and calculated to +15mm in the Z axis. The on-orbit center of mass shall be calculated based upon the measured X and Y, and calculated Z, launch center of mass.

(Ref. CCR 424-12-26-002)

5.1.3 Mass Measurement Accuracy

A deviation to the GIRD (Revision A, Change 3), paragraph 3.3.2 requirement for mass measurement accuracy has been approved.

In lieu of measuring the mass of the TES instrument to ± 0.1 kg, it shall be measured to ± 0.1%.

(Ref. CCR 424-12-26-003)

5.1.4 Spacecraft Gyro Signal Access

A deviation to GIRD (Revision A, Change 3) paragraph 5.1.1, Electrical Interfaces, has been approved to add a High Rate Spacecraft Gyro data line between the spacecraft and the TES instrument. This line will use an RS-422 interface and will provide uncompensated non-time tagged high rate gyro data in gyro coordinates. The data, delineated in Table 3-2, is sampled at a Pre-Butterworth filter output.

(Ref. CCR 424-12-26-004)

5.1.5 Spacecraft Ancillary Data

A deviation to GIRD (Revision A, Change 3) Paragraph 6.5.1 has been approved which modifies the usage of spacecraft to instrument transfers over the MIL-STD-1553 bus.

In addition to commands, memory loads, and time data, the spacecraft shall supply spacecraft ancillary data to the instrument as delineated in TES UIID Table 3-l. The added spacecraft ancillary data contains data required for TES motion compensated pointing.

5.1.6 TES Cooler Software Programming Language

A deviation to GIRD (Revision A, Change 3) paragraph 8.2 has been approved, which allows TES to deviate from the implementation of software for the TES Cryocoolers.

In lieu of the requirement for the implementation of software using ADA, FORTRAN, or C programming languages in the TES instrument, the use of the FORTH language in implementing the TES Cryocooler subsystem will be allowed.

(Ref. CCR 424-12-26-009)

5.1.7 Instrument Disturbance Torque

A deviation to GIRD (Revision A, Change 3) section 3.10 has been approved for all instruments that potentially allows non-compliance with the constant, periodic, or linear force (assumes moment arm) disturbance torque limits governed by the GIRD under the following conditions.

Known and estimated instrument and Common spacecraft disturbances will be used as inputs to an appropriate model of the spacecraft dynamics to analytically determine the expected on-orbit pointing stability and jitter performance at each instrument interface. Calculated responses produced by the Aura Observatory pointing stability and jitter model will be used to assess whether instrument imposed pointing stability and jitter requirements on the observatory are being met.

The Aura Observatory pointing stability and jitter model will be updated throughout the program to reflect substantial changes to spacecraft/instrument models or disturbances. Approved disturbance profiles, which reflect the need for instrument disturbances to fall below the maximum levels specified in the GIRD in some frequency bands in order to accommodate exceedances in others, will be documented in the ICD between the Common spacecraft and each instrument.

If the calculated responses from the jitter and stability capability analysis indicate that any instrument pointing stability requirement is not being met with sufficient margin, the source(s) responsible for pointing stability degradation may be required to take measures to reduce or modify the profile(s) of their generated disturbances. Pointing stability non-compliance will be evaluated on a case by case basis by the Aura Project to determine the most effective solution toward compliance.

5.1.8 TES Reflected Ripple Current, Operational Transients, and Conducted Emissions

A deviation has been approved which allows TES to deviate from GIRD (Revision B) Paragraph 5.3.5.2.4-Instrument Reflected Ripple Current, Paragraph 5.2.5.2.3-Instrument Operational Transients, and Paragraph 10.11.1-Conducted Emission, Power Leads.

In lieu of GIRD Paragraph 5.3.5.2.4-Instrument Reflected Ripple Current: "The peak-to-peak load current ripple generated by the instrument shall not exceed 5% of the average current on the quiet bus and shall not exceed 25% of the average current on the noisy bus." Instead, the following will be allowed: "The peak-to-peak load current ripple generated by the instrument shall not exceed 5 percent of the average current on the quiet bus and shall not exceed 200% of the average current on the noisy bus."

In lieu of Paragraph 5.2.5.2.3-Instrument Operational Transients: "Operational transients on the quiet bus that occur after initial turn-on shall not exceed 125% of the peak operational current drawn during normal operation. The maximum duration of the transients shall not exceed 50 msec. Operational transients on the noisy bus that occur after initial turn-on shall not exceed 10.0 Amps. The maximum duration of the transients shall not exceed 10 msec."

In lieu of 10.11.1-Conducted Emission, Power Leads: "Narrowband conducted emissions of a component/instrument on power and power return leads shall be limited to the levels specified in Figure 10-8 when measured in accordance with CEO1 (30Hz to 20KHz) and CEO3 (20KHz to 50 MHz) test methods of MIL-STD-462. The measurement bandwidth shall be as specified in Figure 10-8". Instead the following will be allowed:

"Narrowband conducted emissions of a component/instrument on noisy power and power returns leads shall be limited to the levels specified in Figure 10-8-A when measured in accordance with CEO1 (30Hz to 20KHz) and CEO3 (20KHz to 50MHz) test methods shall be as specified in Figure 5-1".

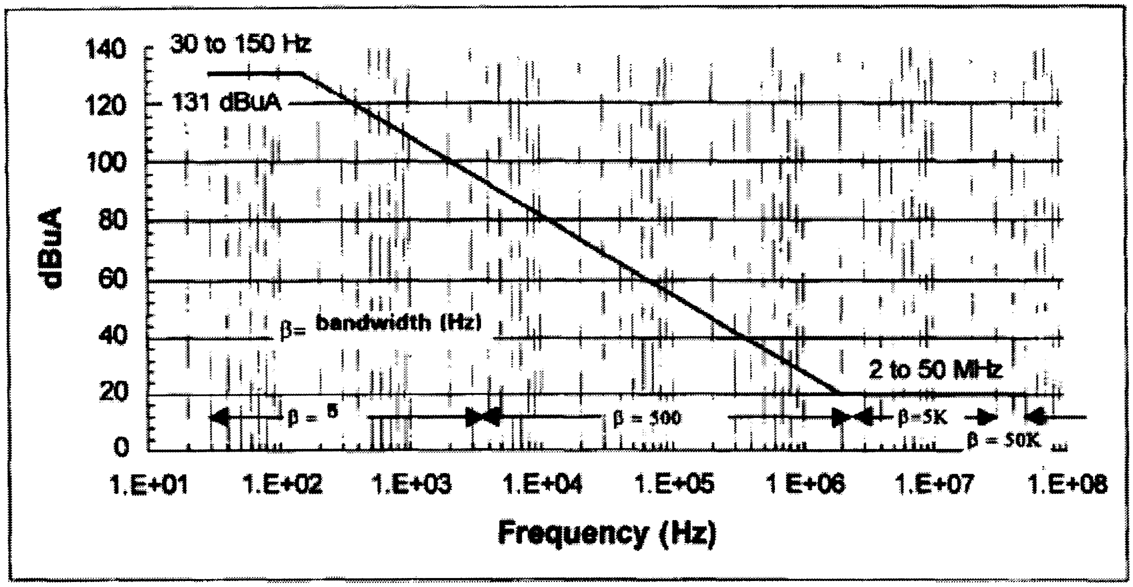


Figure 5-l Narrowband Conducted Emissions

(Ref. CCR 424-12-26-006-R1)

5.1.9 Checksum

A deviation has been granted which allows TES to deviate from GIRD (Revision A, Change 3) Paragraph 6.5.8.2-Engineering Data Packetization, specifically, Note 10 of Figure 6-4, Use of Reed Solomon error correcting code makes use of this checksum optional.

Therefore, in lieu of GIRD Paragraph 6.5.8.2-Engineering Data Packetization, Note 10 of Figure 6-4, stating that an arithmetic checksum of the data being placed in the last two octets of the instrument data field as a data error indicator, the TES instrument will not make use of the last two octets of the instrument data field.

(Ref. CCR 424-12-26-001)

5.1.10 Instrument Discrete Commands

For TES, a deviation to GIRD (Revision B) Paragraphs 5.1.1 and 5.2.6.1 has been approved, which allows the addition of a Discrete Command Interface between the TES Instrument and the Spacecraft. These discrete commands allow the TES Instrument to switch between the Spacecraft provided Noisy Bus-A and Noisy Bus-B and/or Quiet Bus-A and Quiet Bus-B.

(Ref. CCR 424-12-26-013)

5.1.11 Remote Terminal Address Assignment

For TES, a deviation to the GIRD (Revision B), paragraph 6.5.5.4, Instrument Remote Terminal (RT) Address Assignment, has been approved. The deviation removes the requirement for the RT address to be externally selectable, The RT address assignment shall be documented in the TES to Spacecraft ICD.

(Ref. CCR 424-12-26-017)

5.1.12 Connector Keying

For TES, a deviation to the GIRD (Revision B), paragraph 5.4.5.3, Keying, has been approved. GIRD paragraph 5.4.5.3 states "Connectors shall be different sizes, different types, or uniquely keyed to prevent improper connection." The deviation allows the following exceptions to GIRD paragraph 5.4.5.3:

1) Connectors associated with the TES Command and Telemetry Interface Bus A and B may be physically identical to each other (except for unique reference designator labels) but different than all other connectors on the TES Spacecraft Interface Plate and Power relay Box.

2) Connectors associated with the TES High Rate Data link A and B may be physically identical to each other (except for unique reference designator labels) but different than all other connectors on the TES Spacecraft Interface Plate and Power relay Box.

(Ref. CCR 424-12-26-016)

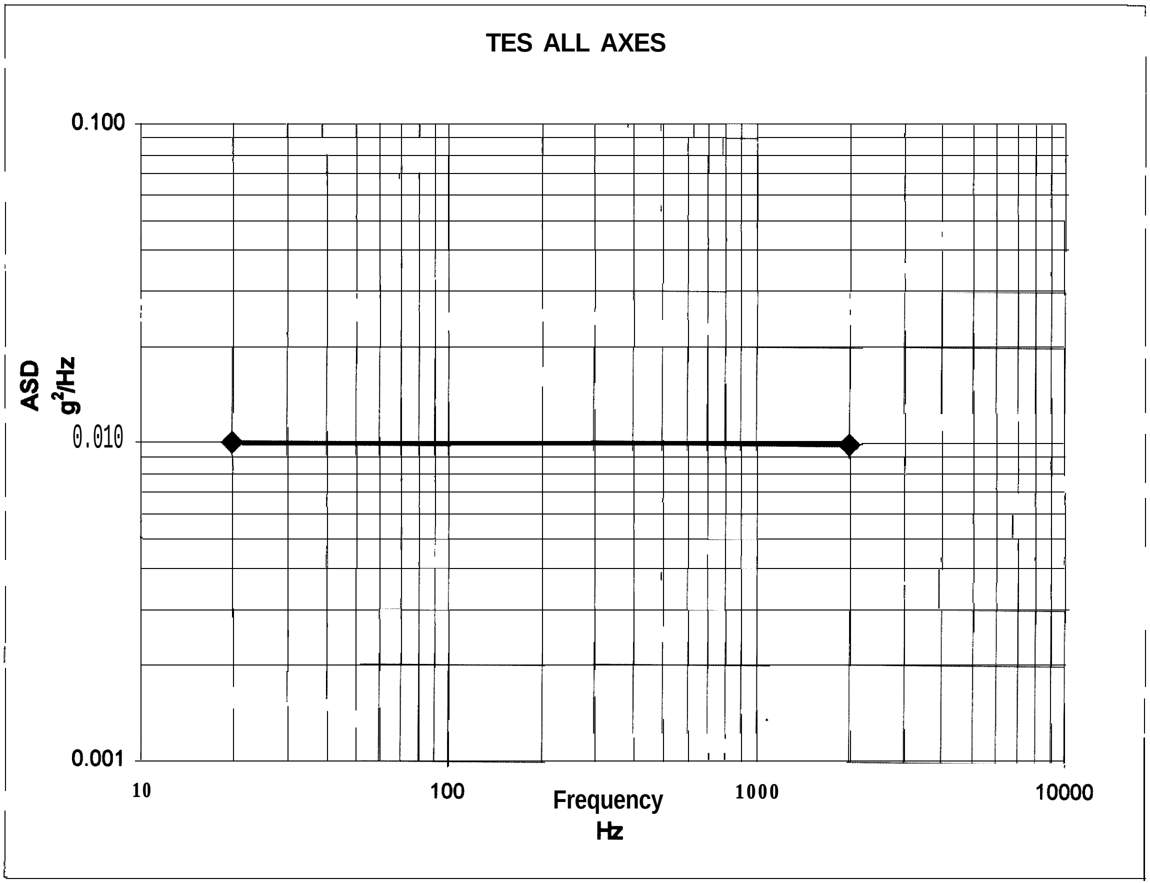
5.1.13 TES Random Vibration Levels

For TES, a deviation to the GIRD (Revision B, paragraph 10.1) has been approved which modifies the required random vibration levels on the Protoflight instrument.

In lieu of using the Random Vibration levels for the Protoflight Instrument, specified in Table 10.1 paragraph 10.1 of the GIRD, use the following Table for all axes.

Table 5-l Protoflight Random Vibration Test Spectra
for the TES Instrument

TES ALL AXES			
FREQ (Hz)	ASD **(G^2/Hz)**	SLOPE **(db/oct)**	OVERALL **(grms)**
20	.01	0.0	4.45
2000	.01		



(Ref. CCR 424-12-26-020)

5.1.14 <u>TES Electronic Interface' Redundancy (RT-Remote Terminal)</u>

A deviation has been approved which allows TES to deviate from GIRD (Revision B) Paragraph 6.5.5.1 - Electrical Interface.

Each electrical interface between the instrument and the C&T bus shall be redundant. Each functionally distinct instrument RT shall be redundant. Each RT shall be individually transformer coupled to both the primary and redundant C&T buses.

No single failure in the C&T bus electrical interface circuit on either the instrument side of the interface or the spacecraft bus side of the interface shall cause the instrument to lose the capability to communicate with the spacecraft over at least one of the C&T buses via each functionally distinct RT.

(Ref. CCR 424-12-26-007-R1)

5.1.15 Sine Vibration

For TES, a deviation to the GIRD (Revision B, paragraph 10.2) has been approved which modifies the required Sinusoidal Protoflight/Qualification Test Levels for the protoflight instrument.

In lieu of the Sinusoidal Protoflight/Qualification Test Levels specified in Table 10-3 and Figure 10-l in each of three orthogonal axes, the TES Instrument shall be subjected to the test levels documented in the following Table 5-2 and Figures 5-l thru 5-3.

Table 5-2 TES Sinusoidal Protoflight/Qualification Test Levels

AXIS	FREQUENCY (HZ)	LEVEL (G)	SWEEP RATE
X	5 - 5.6	.5" D.A.	4 oct/min
	5.6 - 25	± 0.8	4 oct/min
	25 - 35	± 0.8	1.5 oct/min
	35 - 40	± 0.8	4 oct/min
	40 - 50	± 1.0	4 oct/min
Y	5 - 6.3	.5" D.A.	4 oct/min
	6.3 - 15	± 1.0	4 oct/min
	15 - 25	± 0.5	4 oct/min
	25 - 35	± 1.0	1.5 oct/min
	35 - 40	± 1.0	4 oct/min
	40 - 50	± 0.5	4 oct/min
Z	5 - 6.3	.5" D.A.	4 oct/min
	6.3 - 15	± 1.0	4 oct/min
	15 - 25	± 0.5	4 oct/min
	25 - 35	± 2.0	1.5 oct/min
	35 - 40	± 1.0	4 oct/min
	40 - 50	± 0.5	4 oct/min

Note:

1 Protoflight levels shown are 1.25 times maximum expected flight levels.

2 Test axes are in spacecraft coordinate axes.

3 For similarity to flight responses, the above levels shall be notched at critical frequencies (if required) to limit structural loads to 1.25 x flight limit loads.

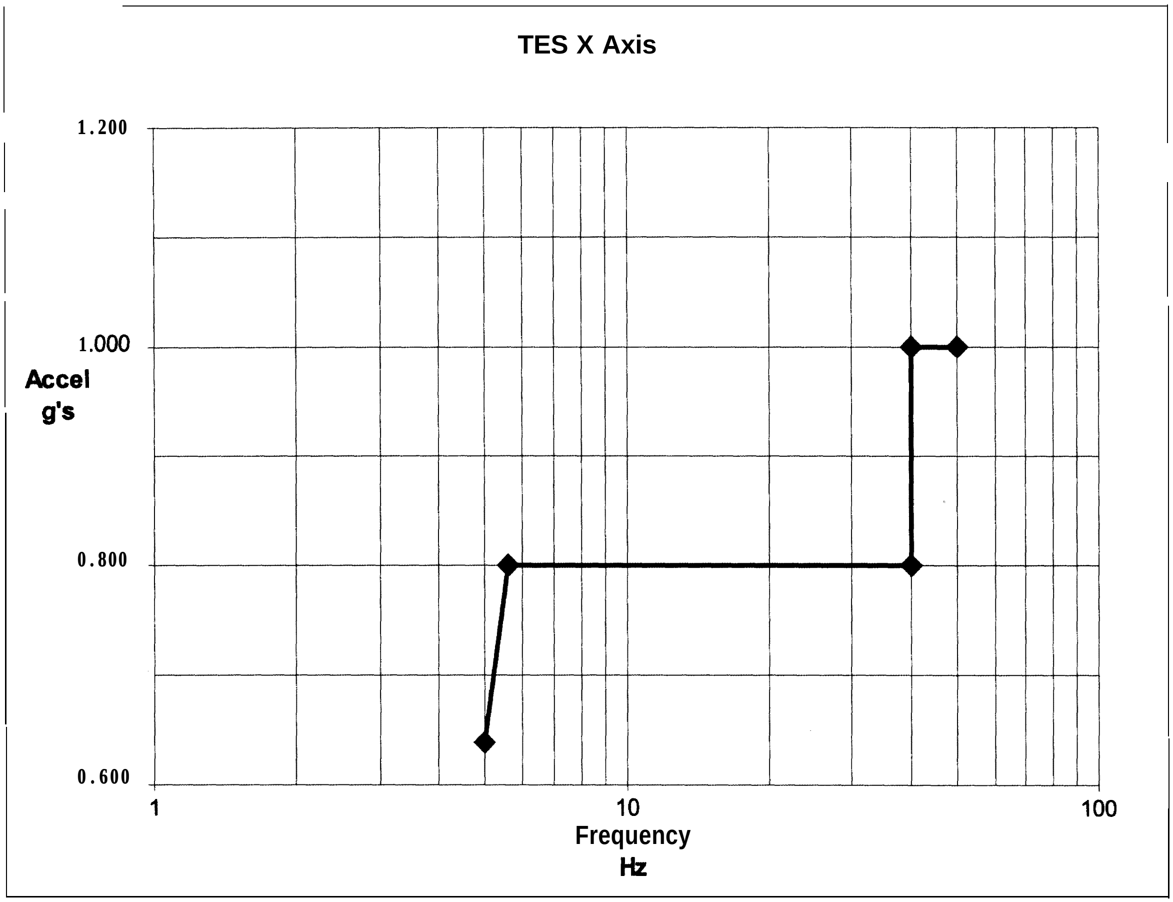


Figure 5-2 Sinusoidal Protoflight/Qualification
Test Levels (X-Axis)

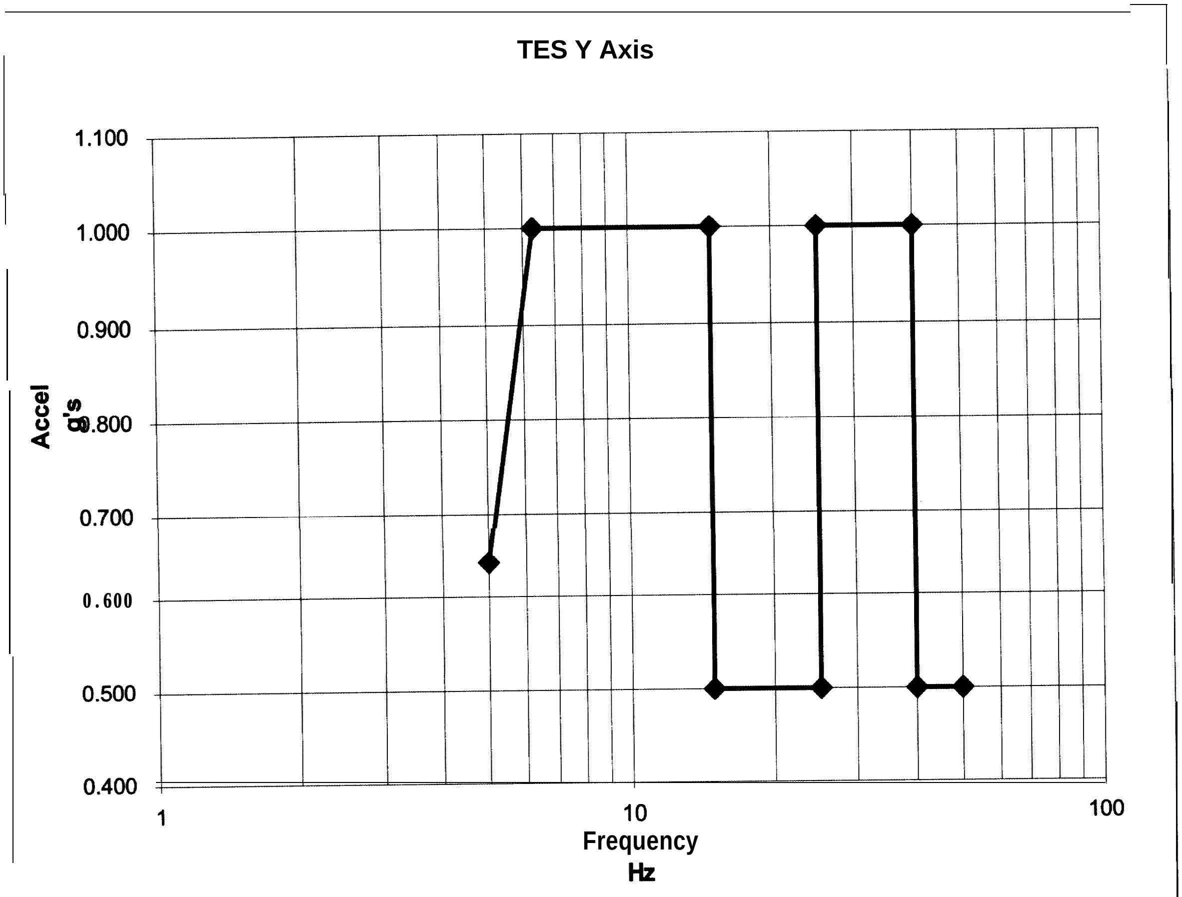


Figure 5-3 Sinusoidal Protoflight/Qualification Test Levels (Y-Axis)

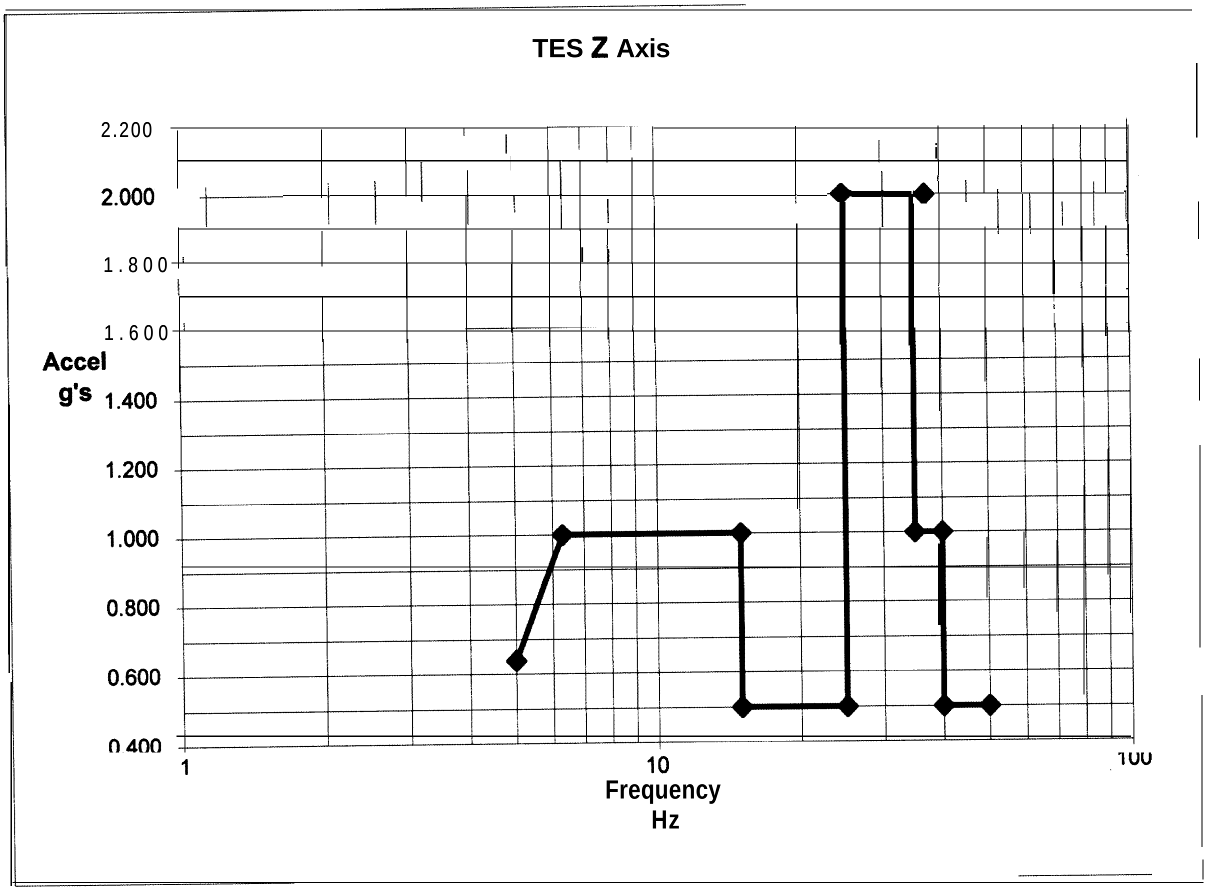


Figure 5-4 Sinusoidal Protoflight/Qualification Test Levels (Z-Axis)

5.1.16 Time Code Data Spare Octets

For TES, a waiver to the GIRD (Revision B) paragraph 6.5.7.2.1 Time Code Data and Format has been approved which modifies the format of time code data transmitted to the instrument.

Rather than receiving 16 octets of time code data from the spacecraft, TES shall only receive eight octets. The trailing eight spare octets have been deleted.

(Ref. CCR 424-12-26-026)

5.1.17 Use of Test Points During Acceptance Verification

For TES, a deviation to the GIRD (Revision B), paragraph 5.6.1f, Test Point Interfaces, has been approved. GIRD paragraph 5.6.1f states, "Test points shall not be used for acceptance or qualification verification of the instrument performance requirements/ The deviation allows the use of connectors J17 and J19 during observatory integration and test under ambient pressure conditions to provide power to the detector cold block heater and sample the reference laser fringes, respectively, so that the instrument can be operated.

(Ref. CCR 424-12-26-028)

5.1.18 TES Instrument Conducted Emissions, Power Leads (CEO3 Broadband only)

A waiver to the GIRD (Revision B) paragraph 10.11.1, Conducted Emission, Power Leads, has been approved. This waiver will allow TES to deviate from the GIRD requirement to perform the broadband portion of the STD-461 CEO3 test and measurement, in order to simplify and expedite the test. This waiver does not allow deviation from the CEO3 narrowband test – it shall be performed per the GIRD requirement. The information acquired from the CEO3 narrowband test, which is conducted first, is usually consistent with the results of the broadband portion of the CEO3 test (if the CEO3 narrowband test is compliant, then the broadband test will usually be compliant. If the CEO3 narrowband test has exceedances, then the broadband test will usually have exceedances). The test result reporting for the CEO3 narrowband test shall provide sufficient data for determining compliance of the TES instrument to the GIRD requirement, independent of the broadband test results. CH-02

(Ref. CCR 424-12-26-030)

5.1.19 TES Instrument Conducted Emission, Antenna Terminal (CE06)

A waiver to the GIRD (Revision B) paragraph 10.11.2, Conducted Emission, Antenna Terminal has been approved. This waiver will allow TES to omit the GIRD requirement to perform the MIL-STD-461 CEO6 test and measurement, which is intended to determine if conducted emissions from EOS Aura instruments with transmitting or receiving antennas, are within the GIRD narrowband limit of 34 dB micro-volts and the broadband limit of 40 dB micro-volts. The CEO6 test is unnecessary for TES since the instrument design does not employ transmitting or receiving equipment or an antenna system.

(Ref. CCR 424-12-26-031)

5.1.20 TES Instrument Radiated Broadband Emissions, Electric Field (RE02/BB)

A waiver to the GIRD (Revision B) paragraph 10.11.6.2, Radiated Broadband Emissions, Electric Field, has been approved. This waiver will allow TES to deviate from the GIRD requirement to perform the broadband portion of the STD-461 RE02 test and measurement, in order to simplify and expedite the test. This waiver does not allow deviation from the RE02 narrowband test - it shall be performed per the GIRD requirement. The information acquired from the RE02 narrowband test, which is conducted first, is consistent with the results of the broadband portion of the RE02 test (if the RE02 narrowband test is compliant, then the broadband test will usually be compliant. If the RE02 narrowband test has exceedances, then the broadband test will usually have exceedances). The test result reporting for the RE02 narrowband test shall provide sufficient data for determining compliance of the TES instrument to the GIRD requirement, independent of the broadband test results. CH-02

(Ref. CCR 424-12-26-033)

CH-02
Page #
Only

5.1.21 Conducted Emissions Power Leads (CE01/CE03 Narrowband/CE03 Broadband)

For TES, a waiver to the GIRD (Revision B) paragraph 10.11.1, Conducted Emissions Power Leads (CE01/CE03 Narrowband/CE03 Broadband), has been approved.
This waiver modifies the limit requirement for allowable conducted emissions for the TES instrument as specified in GIRD Figure 10-8, to allow for an increase to the limits as specified in Figure 5.1.21-l and Figure 5.1.21-2. CH-06

Given the GIRD-specified source impedance of 2.0 ohms from 20 KHz-to-100 KHz, and 20 ohms from 100 KHz-to-10 MHz, the adjusted limits for the CE01/CE03 narrowband/ CEO3 broadband tests would 'result in a calculated ripple voltage (not inclusive of power line impedance) of approximately 0.63 mVp-p and 6.3 mVp-p respectively.

Other instrument components, which share the same Secondary Converter Electronics as the TES instrument, could be exposed to this noise due to coupling effects. However, all EOS Aura instruments are tested to the GIRD-specified Conducted Susceptibility CS02 limit of 3 Vp-p from 50 KHz-to-400 MHz, which would provide a minimum of 123.5 dBuV of margin (inclusive of 6 dB safety margin), when compared to these levels.

CH-06

TES CE01/CE03 NB Adjusted Limits

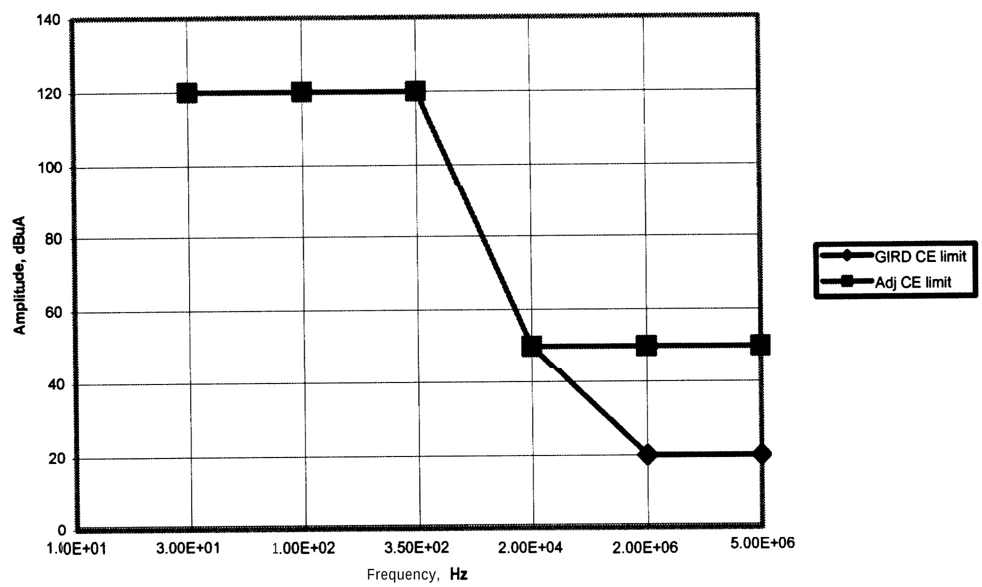


FIGURE 5.1.21-1

TES CEO3 BB Adjusted Limit

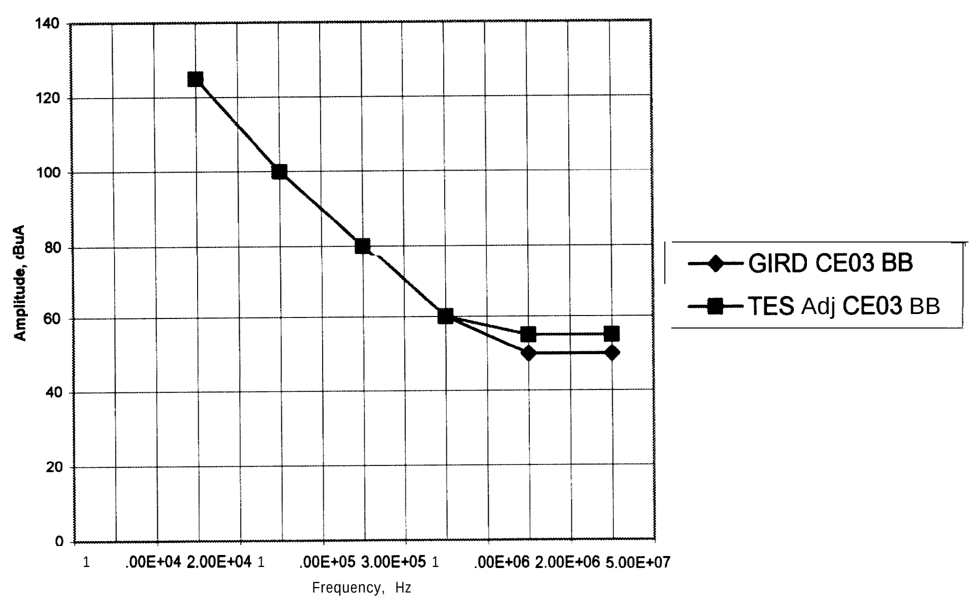


FIGURE 5.1.21-2

(Ref. CCR 424-12-26-035)

5.1.22 Radiated Emissions Electric Field (RE02), Narrowband Emissions

For TES, a waiver to the GIRD (Revision B) paragraph 10.11.6.1, Radiated Emissions Electric Field (RE02), Narrowband Emissions, has been approved. This waiver modifies the limit requirement for allowable radiated emissions for the TES instrument as specified in GIRD Figure 10-12, to allow for an increase to the limits as specified in Figure 5.1.22-1, below. CH-06

These adjusted limits would be no less than 55 dB (including 6 dB safety margin) below the GIRD-specified Radiated Susceptibility RS03 limit of 2 V/m (126 dBuV/m), from 14 KHz to 2 GHz.

These adjusted limits do not affect the narrowband emissions EM1 sensitivity limits for the MLS instrument, as specified in GIRD section 10.11.6.1, Table 10-9a.

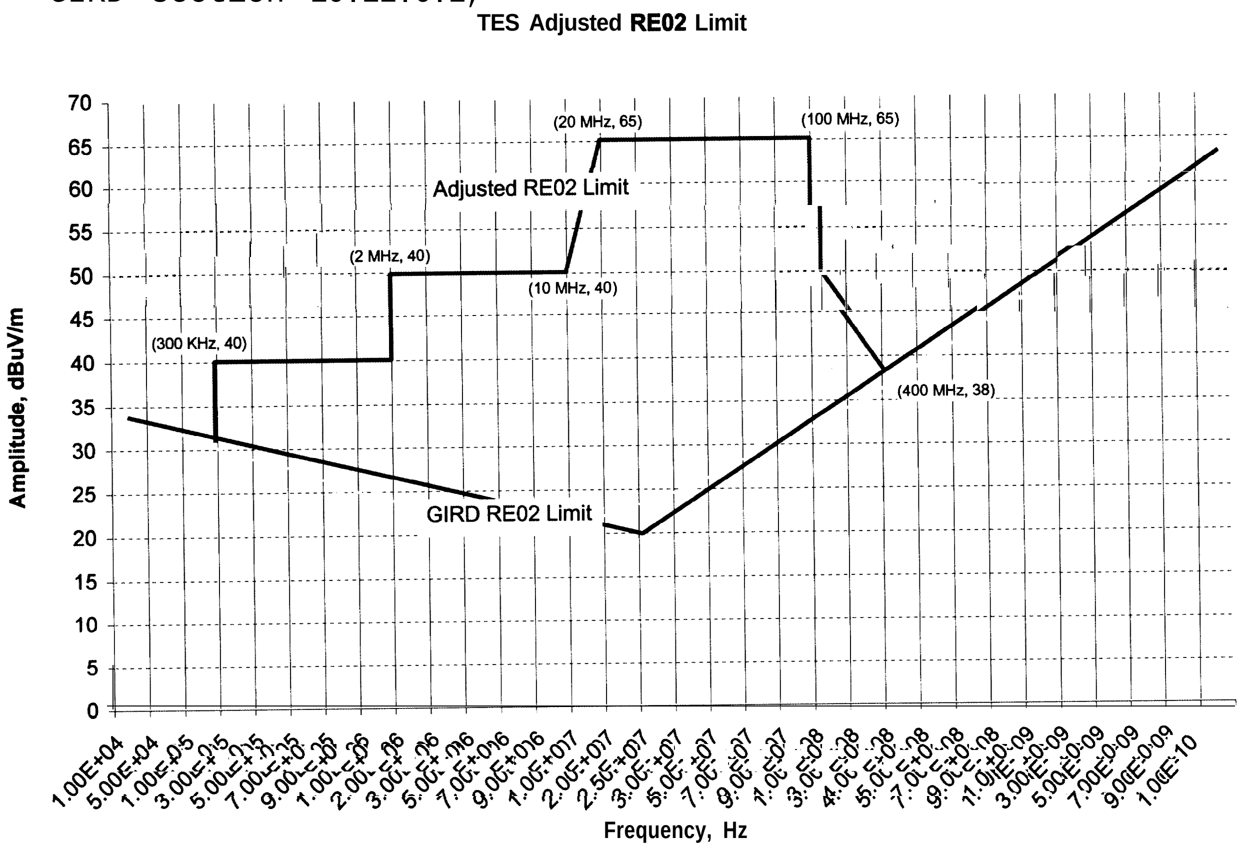


FIGURE 5.1.22-I

(Ref. CCR 424-12-26-036)

5.1.23 Primary Power Isolation

For TES, a waiver to the GIRD (Revision B) paragraph 5.3.2.1.3, Primary Power Isolation, has been approved. This waiver reduces the requirement for primary power signal and return lead isolation resistance (dc) from chassis, of greater than 1 MΩ, to an isolation resistance of greater than or equal to 0.8 MΩ. CH-06

This modification is applicable to TES Quiet Bus A and B. The TES Noisy Bus primary power isolation resistance shall remain compliant with the GIRD requirement as described in paragraph 5.3.2.1.3.

(Ref. CCR 424-12-26-037)

5.2 MAR DEVIATIONS/WAIVERS

5.2.1 Reduce Soak Time During T/V Testing

For TES, a deviation to the MAR, paragraph 3.6.1, Thermal-Vacuum, has been approved. MAR paragraph 3.6.1 states, "…the instrument shall be soaked for a minimum of 16 hours at each temperature extreme of each cycle." The deviation allows the instrument to be soaked for sufficient time to complete a project approved Comprehensive Performance Test (CPT) but no less than four hours after temperature goals have been achieved.

(Ref. CCR 424-12-26-029) CH-03

5.2.2 Acoustic Testing at the Instrument Level

A waiver to the MAR (424-11-13-02) paragraph 3.4.2.1, Design Verification, has been approved which relieves TES from the requirement to conduct acoustic testing at the instrument level. The option to conduct acoustic testing can be exercised by TES management at JPL. The risk associated with deferring acceptance acoustics testing to the Observatory Level is considered low by the Aura Project.

(Ref. CCR 424-12-26-032)

APPENDIX A

ACRONYM LIST

APPENDIX A

ACRONYM LIST

ECI	Earth Centered Inertial
EOS	Earth Observing System
FOV	Field of View
GIRD	General Interface Requirements Document
GSFC	Goddard Space Flight Center
IAC	Instrument Alignment Cube
ICD	Interface Control Document
IDD	Instrument Description Document
in	Inches
JPL	Jet Propulsion Laboratory
kg	Kilograms
MAR	Mission Assurance Requirements
Mbps	Megabits per second
MLS	Microwave Limb Sounder
mm	Millimeter
msec	Millisecond
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
TES	Tropospheric Emission Spectrometer
UIID	Unique Instrument Interface Document
vdc	Volt Direct Current